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EFFECT OF EQUIPMENT UTILISATION ON ECONOMICS OF MINING PROJECT – A CASE STUDY

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ABSTRACT

Open pit mining in the world today has cyclic reappearance with prominent role in to mining sphere. The proportion of mineral own by open cast mining is increasing from year to year. This is due to the rapid strides made in the field of manufacture of open pit machinery. There has been a design explosion in the field of machinery, which have grown into enormous sizes with production capacities hitherto unimagined.

In any commercial establishment, the objective is to get maximum return per unit of investment. Improper utilization of HEMM have negative consequences on the production, productivity and production cost leading to loss of revenue. There is definite need to highlight the impact of utilization of equipment on the economics of the project.

In this paper, an attempt is made to analyse the performance of opencast mining equipment in various dimensions and to study the impact of percentage utilization of mining equipment on the cost of production.

Key words: Performance, Productivity, Useful Life, Cost of Production, Utilisation

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1. INTRODUCTION

In India, open pit mining on a large scale in mechanized form is coming up. Bu because development in the field of mining machinery manufacture is yet in embryonic stage either in size or in design sophistication, the open pit mines have to depend on imported equipment to a considerable extent.

The question her arises whether the existing heavy earth moving machinery- the mainstay of open pit mechanization and representing such heavy capital investments- are being properly utilized. Are lessons from their performances in past being learnt? What do they implicate about future trend in production performances? Any mine management has to know how best we are utilizing these capital-intensive assets and if performance is bad how to improve.

2. EQUIPMENT PERFORMANCE AN OVERVIEW

Machine performance can be defined in different ways. The cost of production and productivity are directly and greatly related to the performance of the machines deployed. The following factors are usually represented as the yardsticks for measuring the machine performance.

2.1. Productivity

Productivity is the output of the equipment per unit time. The terms like hourly production, daily production, monthly production and yearly production are also used to denote the productivity of the equipment. All these values must be taken as the average of production over a period of time.

2.2. Cost per ton of material handled / excavated

Due to competitive market scenario, the cost of production becomes an important factor while considering the economics of the mining project. The cost per ton of material handled/won includes the owning cost of equipment, which includes the depreciation, interest on capital etc., and the operating cost, which includes the cost on maintenance, energy and the labour.

2.3. Useful life of the equipment

It is established that most repairable HEMM exhibit a "bath tub curve". It characterizes three phases of failure rates i.e. Decreasing Failure Rate (DFR) during early period of life or infant mortality period, Constant Failure Rate (CFR) during most parts of useful life of equipment and Increasing Failure Rate (IF) during aging or wear out life of equipment.

It is necessary to discard the machine once it crossed the useful lifetime, since the operation during wear out life of equipment will not be economical. This parameter is very important since this will affect the return on investment.

3. FACTORS INFLUENCING THE PERFORMANCE

The following factors influence the performance of the equipment. They can be put under two main headings. They are controllable and non controllable factors. The non controllable factors are the geological conditions and environmental factors like monsoon. The controllable factors are discussed under the headings – design aspects, efficiency of maintenance management, effectiveness of mine scheduling, skills and motivation imparted to the machine operators etc.

3.1. Design factors

The performance of a machine depends on the availability of the machine which in turn depends on its "built in" reliability feature [3, 7, 8]. It is a performance barometer of overall machine conditions and an integral part of an engineering design. It can be increased by design effort and/or addition of quality material or modification.

3.2. Maintenance factors

Proper maintenance is essential in order to eliminate or to mitigate the number of failures and the machine downtime. Necessary workshop facilities, skilled maintenance crew and proper tools need to be available. Efficient spare parts management is a must.

3.3. Managerial factors

A mine must have sound management organization, which will draw sound plans for profitably utilizing the equipment. An important prerequisite is the availability of sufficient maintenance record of good quality. Indeed maintenance and utilization records need no longer be perceived as costly overhead, but as a strategic tool to maximize asset utilization.

3.4. Operational factors

The productivity of the equipment lies in the hands of the operator. Only the skilful and efficient operator obtains reduction in the cycle time and high productivity. Proper motivation and training are essential to achieve the same.

3.5. Environmental factors

The environmental factors like monsoons, the geological conditions of the deposit also affect the machine productivity to a greater extent.

4. MEASURES TO IMPROVE THE PERFORMANCE

- The following steps can be taken to improve the performance of equipment.
- Redesign of machine components to have high reliability and ease of access and maintenance.
- Incorporating fault diagnosing elements to reduce the time spent in falt diagnosing and thereby decreases the machine down time.
- Having proper maintenance facilities, skilled workmen, maintenance schedule, communication system between mine and workshop.
- Ensuring efficient spare parts management system
- Maintaining reliable maintenance and utilization records
- Analyzing the important causes of high frequency of failures, delay in repair, idle time and take necessary actions to improve asset availability and utilization
- Providing quality training to the machine operators and maintenance personnel
- Giving motivation to machine operators by effective incentive schemes

Poor utilization of HEMM and their consequences have a significant effect on the mineral production, productivity and cost of production [4, 5]. Poor utilization of any HEMM such as shovel, dumper, dozer etc during the working shift will lead to inevitable stoppage of production which will result in loss of revenue. (10)

5. COSTS INCURRED DUE TO MACHINE STOPPAGE

The cost incurred due to stoppage is presented under the following headings.

5.1. Loss of Production

Stoppage of equipment will lead to loss of production resulting in loss of revenue. Te shovel dumper system used in the mine is capable of giving an output of 226 tons per hour, if two dumpers are employed. Assuming that the efficiency of system falls by 50% due to the absence of one dumper, the system with one shovel and dumper will give an output of 113 tons per hour. Hence the loss of production due to stoppage of shovel for one hour results in loss of production by 226 ton and one dumper by 113 ton.

5.2. Owning Cost

The book value of the equipment decreases day by day whether it is utilized or not. The interest on capital investment is also added up whether it is used or not, these two costs along with the interest and depreciation on the spare parts stored constitute the owning cost. This cost will add up to the cost of production.

Table 1 Estimation of Ownership and Operating Costs of Equipment

Costs	Notations
Procurement cost (delivered price)	A
Installation / Erection cost	B
Total initial investment	A+B
Depreciation	C
Interest	D
Capital charges	C+D
Insurance and taxes	E
Ownership cost	C+D+E
Cost of lubricants	F
Cost of other consumables materials and spare parts	G
Wages for maintenance labor for PPM and repairs including social charges	H
Maintenance cost	F+G+H
Energy cost	I
Machine cost	A+B+C+D+E+F+G+H+I
Operating labor cost	J
Direct operating cost / working cost	F+G+H+I+J
Total estimated ownership and direct operating costs	A+B+C+D+E+F+G+H+I+J

5.3. Idleness of Matching Equipment and Operators

The stoppage of shovel will result in keeping the dumpers idle. Moreover, both the shovel and dumper operators will remain idle and hence the owning cost of dumper and the salary of dumper operators will add to the cost of production unnecessarily. Similarly, the stoppage of dumper will result in half idleness of shovel and shovel operators.

6. ECONOMICS OF MECHANIZATION

The following costs or expenditure must be considered while evaluating the economics of equipment.

To ascertain the economy resulting from mechanization of any work process or operation, one must compare the total estimated ownership and direct operating cost and miscellaneous costs incurred on other secondary activities connected with mechanization per unit of production or performance before and after mechanization.

7. INFLUENCE OF MACHINE UTILIZATION ON THE COST OF PRODUCTION

The cost of production per ton of ore is given by the total cost incurred divided by the total production. Total owning cost of equipment remains the same irrespective of the equipment utilization whereas the achieved production decreases, if the utilization is low. Thus the cost per ton of ore increases with decrease in utilization. The contribution of various costs towards the cost of production of magnesite has been shown in Table 2.

Table 2 Cost of Production per Ton of Ore

Particulars	Cost per ton in rupees
Labor charges (A)	919.5
Drilling and blasting (B)	112.97
Spoil removal excluding depreciation and value of spares for shovel (C)	29444.63
Depreciation and value of spares for shovel (D)	7.96
Ore transport (E)	34.00
Royalty (F)	35.00
Overheads (G)	485.90
Other direct expenses (H)	264.84
Total direct expenses (A+B+C+E+F+H)	1660.59
Total indirect expenses (D+G)	493.86
Total expenses (A+B+C+E+F+G+H)	2154.45

The Table 3 gives the impact of utilization of shovel on the cost of production. The following assumptions have been made for the analysis.

- The present day cost of production per ton has been taken as Rs.2154.45 where the percentage utilizations of shovel on total calendar hours basis is 22.84%
- The over head cost and the depreciation of shovel has been taken as constant irrespective of the production.
- The reduction in cost per ton due to the increase in percentage utilization of dumpers, dozer and drill machine has been neglected.
- The other operations like drilling, blasting, manual collection of ore etc are assumed to be able to cope up with the higher utilization and high production and the costs due to these operations are assumed to vary linearly with production.
- For obtaining one ton of magnesite 7.65 ton of spoil has to be removed.
- The costs given in Table 1 are for the production of 46000 tons of magnesite and 350000 tons of spoil.

Table 3 Impact of Shovel Utilization on the Cost of Production

Percentage utilization of shovel on calendar hour basis	10	20	30	40	50	60	70	80	90	100
Yearly production of magnesite in 000 ton	20	40	60	80	100	121	141	161	181	201
Yearly spoil removal in 000 ton	154	308	462	616	770	924	1078	1232	1386	1540
Indirect cost per ton of ore	1136	568	379	284	227	189	162	142	126	114
Direct cost per ton in Rs.	1660	1660	1660	1660	1660	1660	1660	1660	1660	1660
Total cost per ton in Rs.	2796	2228	2039	1944	1887	1849	1822	1802	1786	1774

The variation of yearly production, direct, indirect and total costs per ton of magnesite has been shown graphically in Figures 1 and 2 respectively [6].

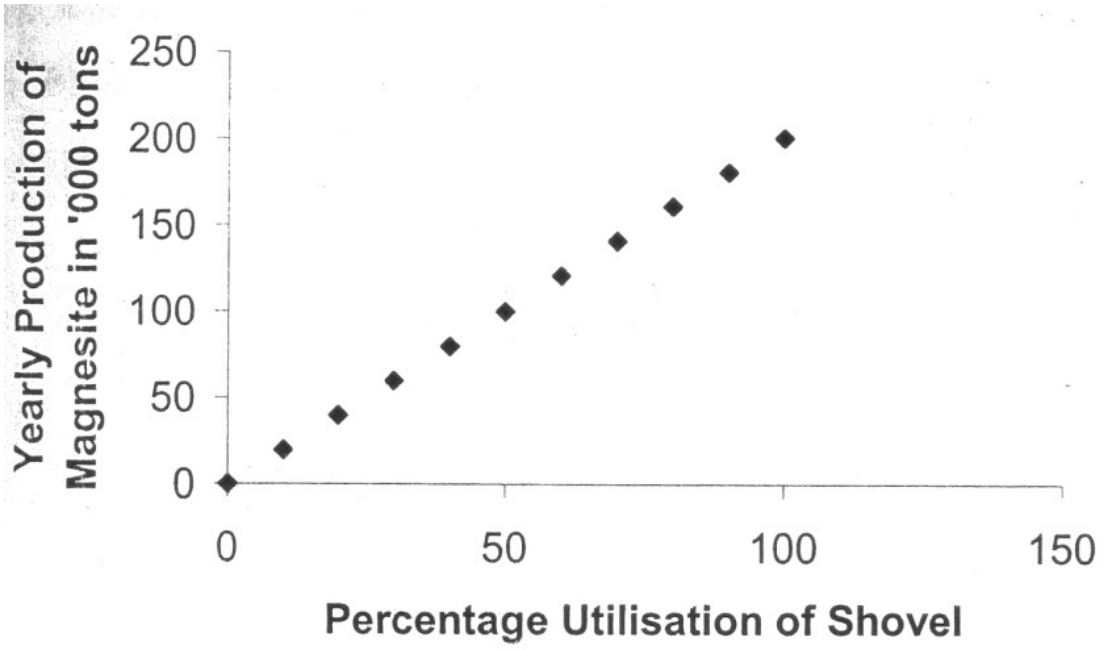

Figure 1 Variation of Yearly Production with Shovel Utilisation

From the graph, it is clear that the rate of decrease in cost of production is sharp when the percentage utilization of shovel increases from 10 to 40%. After that there is no sharp reduction in cost of production with increase in percentage utilization of shovel. Hence the management should attempt to increase the percentage utilization of shovel to at least 40%. If that is achieved, and then the cost of production will reduce to Rs. 1944 which is Rs. 210 less when compared to present day cost of production.

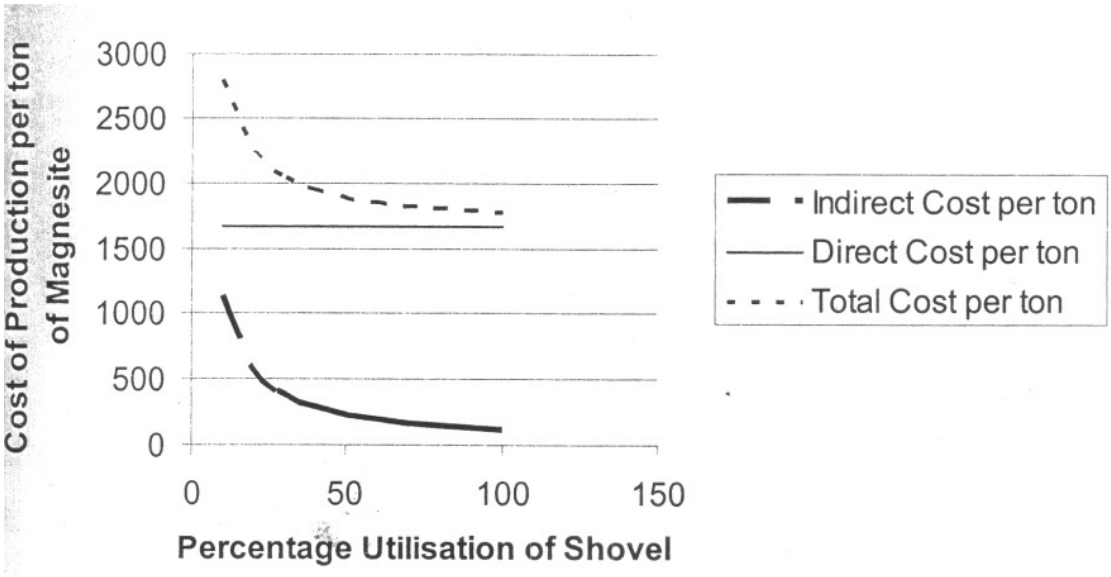

Figure 2 Variation of Cost of Production with Shoval Utilisation

8. CONCLUSION

The performance of mining equipment has been defined in various dimensions. The influence of percentage utilization of mining equipment on the cost of production of mineral has been highlighted.

The views expressed in this paper are of the author and not necessarily of the organisation, he belongs to.

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